Innovation

Illuminating a 'Black Sky'

EPRI Examines Backup Communications to Restore the Grid After a Disaster

By Chris Warren

The term *Black Sky* event has an appropriately ominous ring to it. It refers to natural or human-caused disasters that could result in large-scale disruptions of critical infrastructure for a month or longer. Examples of Black Sky events are powerful hurricanes, earthquakes, and high-altitude electromagnetic pulses.

Last year the Electricity Subsector Coordinating Council, which convenes federal government and power industry leaders, pinpointed Black Sky event response as worthy of additional research. In particular, the council wanted to investigate emergency communication systems that could operate during extended outages to support repairs and service restoration.

"The council is made up mostly of utility CEOs, and its R&D committee identified Black Sky communications as a priority," said Matt Wakefield, director of information, communication, and cyber security research at EPRI. "Along with the North American Transmission Forum, the council asked EPRI to investigate the requirements for an emergency communication system that would be needed if a utility lost its primary and backup control systems—energy management systems and SCADA."

Recent natural disasters such as Hurricane Maria point strongly to the importance of emergency communications. Without voice and data communications, utilities face extreme challenges in dispatching crews, making repairs, load balancing, and other critical activities. The power industry needs effective, reliable tools to meet emergency communications requirements.

EPRI's research builds on the North American Transmission Forum's "Spare Tire" initiative, which identified reliable voice and data communications along with 10 other operational capabilities that would be required to restore grid operations after the loss of control systems. EPRI is documenting requirements for emergency communications during a Black Sky event, assessing technologies to meet the requirements, examining interoperability standards, and developing a technology test plan.

Communication equipment must be able to function in worst-case scenarios—including a Category 5 hurricane, an earthquake of magnitude 7 or greater, a cyber attack or terrorist attack on the power grid, and a high-altitude electromagnetic pulse attack or geomagnetic disturbance.

EPRI examined the capabilities of various voice and data communication technologies during different simulated Black Sky events. "We analyzed how these technologies would likely perform based on their requirements, specifications, and other characteristics," said Wakefield. "For example, the type of satellite phones most utilities have on hand for emergency communications would not work during a high-altitude electromagnetic pulse, but could be well-suited for natural disasters."

Researchers are evaluating the emergency communication capabilities of technology using high-frequency radio and near-vertical incidence skywave propagation. Because these can provide long-distance communication without expensive infrastructure, the military has long used them in remote locations.

In the lab and the field in Manhattan, EPRI and Con Edison evaluated whether the system could interface with a SCADA system used for testing (and not grid operations). The voice component worked fairly well. Data communications worked in the lab but not in the field, revealing the need for additional investigation of shortwave radio's reliability. The investigation highlighted the necessity to rely on multiple technologies to address different Black Sky scenarios.

"It is unlikely that a single technology can work for all solutions," said Wakefield. "We want to map those technologies to operational requirements under specific Black Sky scenarios."

EPRI's report details the strengths and weaknesses of numerous voice and data technologies. Interviews with utility executives revealed that utilities have prioritized Black Sky communications with state and regional emergency operations centers. EPRI will continue to develop and test communication technologies and may collaborate with the U.S. Department of Homeland Security, which has a shortwave radio program with participation from many local emergency and first-responder agencies.

EPRI presented the results of its Black Sky research to the R&D committee of the Electricity Subsector Coordinating Council. EPRI's next step is to develop specifications for a Black Sky communications system and use these specifications to guide vendors and technology providers as they develop systems. EPRI also plans to develop a guide for utilities on system operations and maintenance.

An important question still under consideration: How much preparation is appropriate for these unlikely events? "It's a discussion of how much investment and effort we should put into it," said Wakefield. "It's a critical question to answer because even though these are low-frequency events, they can be very high impact."

Key EPRI Technical Experts

Matt Wakefield, Tim Godfrey, Jay Herman